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Effectiveness of traffic light system on Brazilian consumers perception of food healthfulness

Mayara Lima [a,b,*], Marcela de Alcantara [c], Amauri Rosenthal [d], Rosires Deliza [d]

[a] IT/DTA – Federal Rural University of Rio de Janeiro, BR 465 – Km 07, CEP 23.890-000, Seropédica, RJ, Brazil
[b] Nutrition and Dietetics Department – Federal Fluminense University, Rua Mário Santos Braga, 30, CEP, Niterói, RJ, Brazil
[c] PDJ-CNPq/Embrapa Agroindústria de Alimentos, Av. das Américas, 29501, CEP 23.020-470, Rio de Janeiro, RJ, Brazil
[d] Embrapa Agroindústria de Alimentos, Av. das Américas, 29501, CEP 23.020-470, Rio de Janeiro, RJ, Brazil

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ABSTRACT

Front-of-package (FOP) nutrition labelling schemes were developed to improve consumer's comprehension about the food nutrients associated with non-communicable diseases (NCDs). Several FOPs have already been developed, and Brazil is in the process of evaluating a scheme to introduce in the products. The aim of this study was to investigate the impact of TLS, the scheme proposed by the food industry, on the product healthfulness perception. A study with 141 participants was carried out. A conjoint task was designed considering three categories and levels: types of dairy products (light yogurt, *prato* cheese, and chocolate flavoured milk), Traffic Light System (yes vs. no) and brand (well-known vs. unknown). The effect of TLS on perceived healthfulness was evaluated using a 9-point scales (1: not healthy; 9: very healthy). Results showed that the inclusion of TLS did not influence the perceived healthfulness of the products by consumers, even among consumers with higher interest in healthy eating. These findings suggest that the proposal supported by the food industry does not seem to be the most appropriate, being recommended the development of further studies to compare the efficacy of TLS and other FOP schemes.

1. Introduction

The increasing of obesity and non-communicable diseases (NCDs) is a global concerning [1]. The high availability and accessibility of industrialized products rich in sugar, fat and sodium has been identified as a major factor associated with these problems [2–4]. In an attempt to restrain this advance, several public policies have been proposed to reduce the consumption of foods rich in sugar, sodium and fat, which include advertising restrictions, market regulations, tax differentiations and actions to encourage consumers to make healthier food choices as providing nutritional information [5–7].

The inclusion of front-of-pack (FOP) nutritional schemes is an important public policy [8]. Different FOP have been developed around the world, and these schemes differ in the kind of information they expose and their graphic designs [9]. Research has shown that FOP improves consumer's understanding of nutrition information and their ability to identify healthy products [10]. Currently, FOP nutritional schemes have been already implemented in over 40 countries [11]. Brazil, which was one of the first countries to adopt mandatory nutrition labeling, started in 2014 the 3rd regulatory intervention to implement a FOP nutritional scheme to processed food products. This intervention was attended by representatives of different society sectors [12], which proposed several FOP nutrition labelling after evaluating the results of available studies. The FOP nutrition labelling schemes proposed to be investigated in this intervention were the black e/or red magnifier (suggested by the Brazilian Health Regulatory Agency – ANVISA), which was also investigated in Canada; the black octagon (suggested by the Food and Nutritional Security Interministerial Chamber – CAISAN), implemented in Chile and Uruguay, black triangle (proposed by the Consumer Protection Institute – IDEC and the Federal University of Paraná – UFPR), which is a modification of Chilean' format to meet the demand of Brazilian population [13]; red circle (National

* Corresponding author at: Nutrition and Dietetics Department – Mário Santos Braga Street, 30, 4th Floor – CEP. 24020-140, Niterói – RJ – Brazil.
E-mail address: mayara_lima@id.uff.br (M. Lima).
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Table 1
Socio-demographic characteristics of participants (n = 141).

	Percentage of participants (%)
Gender	
Female	60
Male	40
Age (years)	
18 - 25	40
26 - 35	26
36 - 45	16
46 - 55	13
56 - 65	5
Educational Level	
Primary education	2
Secondary education	42
University degree	16
Postgraduate	38
Socio-economic level[a]	
Low	40
Medium	21
High	39

[a] According to the Brazilian Institute of Geography and Statistics (IBGE).

Health Surveillance System – SNVS), and the traffic light system (suggested by the food industry) [12].The traffic-light system (TLS) is one of the most investigated FOP nutritional schemes around the world [10]. This scheme includes quantitative information about the content of key nutrients (usually sugars, saturated fat and sodium) and classifies them as low, medium or high, using text descriptors and a colour code [14]. However, this scheme requires consumers to create their own judgment considering different nutrient levels, which makes this task difficult [15]. In addition, results presented by Machín et al. [16] show that information about a low nutrient level can increase the healthfulness perception of unhealthy foods that are high in other nutrients, reducing their effectiveness to contribute to improve consumers' food choices. In addition, TLS inclusion may not modify healthfulness perception about unhealthy food products [17], or improve their ability to differentiate them [18]. Although several studies reveal that TLS is not the most effective FOP scheme to guide consumers to healthier food choices [17–19], and researches suggest that nutritional warnings as black octagon and black triangle are the most appropriate alternatives to Brazil [13,20–22], the food industry still supports the adoption of TLS [12]. Therefore, to assess whether this FOP nutritional scheme has the potential to assist Brazilian consumers, the present study aimed at evaluating its impact on the product healthfulness perception.

2. Material and methods

2.1. Participants

A total of 180 people (18–65 years old) were recruited in the city of Rio de Janeiro (Brazil). They were responsible for their household's food purchases. The socio-demographic characteristics of participants are shown in Table 1. All consumers gave written informed consent before starting the study. They provided informed consent at the beginning of the questionnaire. The study was approved by the Brazilian Committee of Ethics in Research (Plataforma Brasil - CAAE33242614.0.0000.5257).

2.2. Stimuli

Three dairy products categories (light yogurt, *prato* cheese, and chocolate flavoured milk) with different nutritional composition were considered. All categories are frequently consumed in Brazil according to Brazilian Institute of Geography and Statistics [23]. They were identified in a preliminary study, in which consumers were asked to evaluate the healthfulness perception of several common foods. The products that were classified in the middle of the scale, i.e. those considered nor healthy neither unhealthy were included in the present study [24]. Packages of real products were manipulated following an experimental design and evaluated by participants.

Table 2
Package factors and levels used in the study.

Factor	Level	Description
Type of Dairy product	3	Light Yogurt *Prato* cheese[a] Chocolate Flavoured Milk
Traffic Light System (TLS)	2	Yes No
Brand	2	Well-known Unknown (fictitious)

[a] Typical Brazilian cheese, which is highly consumed in Southeast of the country.

2.2.1. Experimental design

A conjoint task was designed considering three categorical factors: dairy product (light yogurt, *prato*[1] cheese, and chocolate flavoured milk), Traffic Light System (yes vs. no) and brand (well-known vs. unknown). Table 2 summarizes the factors and levels used in this study. The literature reports that brand and product familiarity are major influences on food purchase and healthfulness perception [25]. The three factors were varied independently from each other, following a full factorial design, which resulted in 12 (3×2×2) combinations. A prototype of the products was created for each combination.

2.2.2. Packages' manipulation

Commercial brands (well-known vs. unknown) of the three dairy products were purchased at a local supermarket. The TLS was inserted on the package following the experimental design. The packages were elaborated by a professional graphic designer from Embrapa Food Technology (Brazil) with previous experience in the design of food packages. All packages were printed on glossy self-adhesive paper and placed in the respective product to be as similar as possible to the products available in the market. Fig. 1 shows examples of the images included in the study. All the compulsory information required by Brazilian legislation was included on the packages. Information about sugar, sodium, total fat and saturated fat content was included in the nutrition panel of all products. The Traffic Light System was included in the front of package, surrounding by a white area around the symbols to increase their salience.

The traffic light system included quantitative information about the nutrients content in 100 g of product as well as the qualitative information about nutrient content using a text descriptor (low/medium/high), and the corresponding colour code (green/yellow/red, respectively). The criteria used to classify sugar, total fat, saturated fat were based on Brazilian food legislation, which is described in the Food Standards Agency [14]. The criteria for sodium followed the Brazilian Health Regulatory Agency [26] to attend the government recommendation for the gradual reduction proposal, which is lower than those used in the UK classification (NILSON et al. [27]) (Table 3).

2.3. Experimental procedure

Participants were asked to imagine they had selected a product at the supermarket. They were asked to look at the product and rate

[1] *Prato* cheese is a very appreciated typical Brazilian cheese.

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Fig. 1. Example of packages used in the stud.

Table 3
Nutritional composition of the products included in the study and Traffic Light System (TLS) classification of nutrients according to theFood Standards Agency.

Category	Portion size (g)	Nutrient content per portion					TLS Classification of nutrient content (Colour of the sign)			
		Calories (kcal)	Sugars (g)	Total fat (g)	Saturated fat (g)	Sodium (mg)	Sugar	Total fat	Saturated fat	Sodium
Light Yogurt	200	96	3,2	2.1	1.7	107	Low (green)	Low (green)	Low (green)	Medium (yellow)
Chocolate flavoured milk	200	198	30	6.4	3.7	116	High (red)	Medium (yellow)	Medium (yellow)	Medium (yellow)
Prato cheese	30	113	0.0	8.7	6.6	149	Low (green)	High (red)	High (red)	High (red)

the perceived healthfulness using 9-point scales (1: not healthful, 5: neither healthy nor unhealthy, 9: very healthful). The products were presented one by one, following a Latin square experimental design in sensory booths under white light.After completing the task, they were asked to respond a series of socio-demographic questions, to indicate whether they are responsible for household food purchase, and the frequency of consumption of the target products. A question was used as inclusion criterion to consumers. Participants had to answer the question "What was the nutrition information you have just seen on the food packages?" and those consumers who did not report the presence of traffic light system were eliminated from the subsequent analyses. Finally, participants filled out the General Health Interest questionnaire, a sub-scale of the Health and Taste Attitude Scale, developed by Roininen et al. [28], translated and validated into Portuguese by Soares et al. [29].

2.3.1. Data analyses

2.3.1.1. Conjoint analysis. Data were submitted to the conjoint analysis (CA) to estimate the importance of the manipulated factors (product category, nutritional information, and brand) related to consumers' perception of product healthfulness. The CA based on the classification is able to estimate the relative importance of several factors from the decomposition of the consumers' attitude, in which a number of complex alternatives are separated by compatible utilities, reconstituting the original assessment [30]. The individual additive model was used to calculate the part-worth utility for each consumer. The factors of the experimental design and all their interactions were considered as fixed sources of variation in the model. Consumer was considered as random effect. A 5% significance level was considered. The individual utility and relative importance of the factors were calculated.

2.3.1.2. Analysis of variance. Analysis of variance (ANOVA) was used to analyze healthfulness ratings of samples used in the study. Data were analyzed in total and according to interest in healthy eating. Tukey's test was used for *post-hoc* comparison of the means at 5% level.

General Health Interest questionnaire and identification of groups with different interest in following a healthy diet

Data from the General Health Interest questionnaire were analyzed using Exploratory Factor Analysis (EFA). EFA is a statistical multivariate technique used to reduce the complexity of a large number of variables to a relatively simple structure, consisting of a smaller number of factors [31,32]. Scores of questions 5, 6, 7 and 8 were reversed prior to analysis. Parallel Analysis was used to determine the number of factors. This analysis minimizes over identification of factors based on sampling error and is superior to reliance solely on eigenvalue scores for the identification of the meaningful number of factors in EFA [33]. The maximum likelihood estimation method and pro max were considered. The items with an absolute factor loading of 0.4 or higher were interpreted as having the meaningful part on the whole domain [34]. Reliability of the factors was estimated using Cronbach's alpha.

The Parallel Analysis yielded a classification of participants into two groups according to the interest in following a healthy diet (items 1, 2, 3, and 4 of the General Health Interest questionnaire, Table 6). The sum of scores was calculated for each participant and ranged from 4 to 28 points. It was split into two groups, corresponding to lower (4–15) and higher (16–28) interest in following a healthy diet. Participants were then assigned to one of the groups according to the sum of his/her scores. Chi-square test was used to evaluate differences between the groups in their gender, age, educational level and socio-economic level.

All data were analyzed using XLSTAT [35].

3. Results

A total of 39 consumers among the 180 participants of the study reported they have not noticed the traffic light labeling and; therefore, they were removed from subsequent analyses. It represented about 20% of total of consumers. Taking into account the socio-demographic characteristics of participants, 98% of them reported being responsible for household food purchases and mentioned that the products evaluated presented high consumption. Cheese, yogurt, and chocolate milk were reported as a daily part

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of their diets for 78, 55, and 42% of them, respectively. The majority of consumers (70%) declared that the information in the traffic light system was used to evaluate the product's healthfulness. The results of the conjoint analysis (Table 4), taking into account all participants who noticed the TLS (n = 141) demonstrated that the type of dairy product was the most important factor considered in the healthfulness evaluation, achieving a relative Importance (RI) of 81.9%. TLS and brand had lower RI (11.3% and 6.8% respectively).

The total part-worth revealed that the *well-known brand* (0.049), the presence of *TLS* (0.016), and the product *light yogurt* (1.203) positively contributed to increase the healthfulness perception. On the other hand, the presence of TLS (-0.016), the *fictitious (unknnown) brand* (-0.049), and the products *prato cheese* (-0.198) and *chocolate flavoured milk* (-1.005) contributed to reduce healthfulness perception. Comparing the evaluated products, chocolate flavoured milk was the one that presented the largest negative impact on participants' evaluation, once its utility was about ten times smaller than the *Prato* cheese.

The results from the ANOVA (Table 5) indicated that there were significant differences regarding the sample's healthfulness perception, as well as among the groups with different levels of interest in healthy eating. Considering all participants, *light yogurt* was the product perceived as healthier, with averages ranging from 6.6 to 6.2. The *prato cheese* samples presented lower healthfulness perception averages than light yogurt, ranging between 5.2 and 5.0, as well the *chocolate flavoured milk*, which ranged from 4.5 to 4.2. No significant differences were found in the product healthfulness perception averages regarding the presence or absence of TLS and well-known or unknown (fictitious) brand. The same pattern was observed across the healthy eating groups (Table 5).

3.1. Exploratory factor analysis of the general health interest questionnaire

Exploratory Factor Analysis of General Health Interest Questionnaire scores indicated that the eight items could be divided into two distinct factors. As shown in Table 6, Factor 1 composed of four items (items 5, 6, 7 e 8) related to *the willingness to not sacrifice pleasure for health*, and Factor 2 was composed by items 1, 2, 3 and 4, all related to *the interest in following a healthy diet*. Values for Cronbach's Alpha test for internal reliability for Factor 1 and Factor 2 was 0.78 and 0.72, respectively.

The results of the segmentation based in the interest in healthy eating revealed that among the 141 consumers, 107 had higher interest in healthy eating and 34 had lower interest. No significant differences were found on gender ($\chi^2 = 1.110$, $P = 0.2943$), educational level ($\chi^2 = 6.086$, $P = 0.1075$) and socio-economic level ($\chi^2 = 1.056$, $P = 0.5897$) among groups. However, consumers with higher interest in healthy eating were older than the group showing lower interest ($\chi^2 = 26.686$, $P = < 0.001$).

Consumers with higher interest in healthy eating presented higher relative importance to the type of dairy product compared with the lower interest group (85.0 vs. 73.5), while the TLS (8.9 vs, 17.3) and the brand (6.8 vs 9.2) presented lower relative importance.

Regarding groups with different levels of interest in healthy eating, the same pattern was observed. However, the part-worth's presented by the low interest group were higher across all levels, except for type of dairy product category (Table 4).

4. Discussion

The inclusion of front-of-pack nutrition labelling is one of the public policies that can be implemented to improve consumer ability to identify unhealthful food products [10]. This is

Table 4
Individual utility and relative importance of factors calculated by analysing the effect and relative importance of factors on consumers' perceived healthfulness.

Factors	Levels	Total (n = 141)		High Interest in health (n = 107)		Low interest in health (n = 34)	
		Individual utility	Relative importance	Individual utility	Relative importance	Individual utility	Relative importance
Brand	*Well-known*	0.049	6.8	0.022	6.1	0.136	9.2
	Unknown	−0.049		−0.022		−0.136	
Traffic Light System	*No*	0.016	11.3	0.012	8.9	0.043	17.3
	Yes	−0.016		−0.012		−0.043	
Type of Dairy Product	*Chocolate Milk*	−1.005	81.9	−1.024	85.0	−0.973	73.5
	Beverage						
	Light Yogurt	1.203		1.226		1.140	
	Prato Cheese	−0.198		−0.201		−0.167	

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Table 5
Average of healthfulness* ratings of samples evaluated by all consumers, and across the groups formed based on the interest in health eating.

Product	TLS	Brand	Total ($n = 141$)	Higher Interest in health ($n = 107$)	Lower interest in health ($n = 34$)
Yogurt	Yes	Well known	6,72^{a}	6.61^{a}	7.13^{a}
Yogurt	No	Well known	6,61^{a}	6.49^{a}	7.07^{ab}
Yogurt	Yes	Unknown	6,52^{a}	6.43^{a}	6.87^{abc}
Yogurt	No	Unknown	6,33^{a}	6.26^{a}	6.60^{abcd}
Prato Cheese	No	Well known	5,22^{b}	5.11^{b}	5.63^{bcde}
Prato Cheese	No	Unknown	5,15^{b}	4.99^{bc}	5.73^{abcde}
Prato Cheese	Yes	Unknown	5,14^{b}	4.95^{bc}	5.83^{abcde}
Prato Cheese	Yes	Well known	5,03^{b}	4.88^{bcd}	5.57^{cde}
Chocolate Flavoured Milk	No	Well known	4,52^{bc}	4.29^{bcd}	5.40^{de}
Chocolate Flavoured Milk	Yes	Well known	4,51^{bc}	4.32^{bcd}	5.20^{de}
Chocolate Flavoured Milk	Yes	Unknown	4,28^{c}	4.25^{cd}	4.40^{e}
Chocolate Flavoured Milk	No	Unknown	4,16^{c}	4.05	4.6^{e}

* Perceived healthfulness was assessed using a 7-point scales (1: not healthful, 7: very healthful). Average values in the same column with different lowercase letters are significantly different according to Tukey's test ($P < 0.05$).

Table 6
General Health Interest questionnaire: Items and loadings from the Exploratory Factor Analysis. Cronbach's alpha coefficient for each factor is also shown.

Item		F1	F2
1	I am very particular about the healthiness of food I eat	0.23	**0.64**
2	I always follow a healthy and balanced diet	0.18	**0.65**
3	It is important for me that my diet is low in fat	−0.15	**0.78**
4	It is important for me that my daily diet contains a lot of vitamins and minerals	−0.009	**0.61**
5	I eat what I like, and I do not worry much about the healthiness of food (R)	**0.78**	−0.03
6	The healthiness of food has little impact on my food choices (R)	**0.95**	−0.22
7	The healthiness of snacks makes no difference to me (R)	**0.52**	0.13
8	I do not avoid foods, even if they may raise my cholesterol (R)	**0.40**	0.31

Loadings higher than 0.40 are highlighted in bold.

particularly relevant considering the increasing of obesity and non-communicable diseases among Brazilian children and adults, which significantly impact the health costs and life quality of the population [36]. The present study has investigated the potential of TLS, a FOP nutritional scheme proposed by the food industry on some food products' healthiness perception. Previous studies have been reported that consumers do not realize the nutritional information presented on the food labelling. On the contrary, they pay more attention to items related to product identification such as name, brand, and image [37–40]. In this context, TLS was used in this study to simplify and to facilitate the task of evaluating the healthiness of foods by consumers. However, it was not even noticed by about 20% of participants.Results showed that the inclusion of TLS had small effect on the evaluation of the products' perceived healthfulness. Although TLS had a relative importance higher than the brand in conjoint analysis (11.3 vs. 6.8), its contribution was not enough to help consumers differentiate products healthfulness, whereas the only design factor that presented significant differences in healthfulness scores was the dairy product category. It implies that the product's scoring was mostly based on the healthfulness perception that consumers already had, i.e. from previous knowledge.

This result reinforces the low impact of the traffic light system to stimulate healthier food choices. Previous studies that compare the potential of different FOP nutritional schemes reported that the use of more salient FOP, as nutritional warnings, significantly decreased the perceived healthfulness of the products, improved participants' ability to interpret nutrition information and their ability to correctly identify products with excessive content of nutrients associated with NCDs, being a better alternative than TLS [17,20,21,41].

Looking at the results according to the type of dairy product, the light yogurt has been perceived as the healthiest product, as expected. In addition to the results reported by Ares, Giménez & Gambaro [42], who found higher intention to purchase for light yogurt suggesting that the term *light* had the appeal of healthfulness, it is worth comment that it received three green signs and one yellow (Table 2). Although *prato* cheese and chocolate flavored milk were perceived as less healthy than light yogurt, they presented intermediate healthfulness scores, which were very close to 5: neither healthy nor unhealthy. The misunderstand regarding the TLS or even the lack of attention about this sign might have been the responsible for the mistakes in the healthfulness perception. Although some types of cheese have a balanced nutritional composition, being rich in proteins, minerals such as calcium and phosphorus, and vitamins [43], *prato* cheese is not suitable for daily consumption because it has high level of fat and sodium. The same is observed with chocolate flavoured milk, due to the sugar and fat content of commercial products, which raise concerns about the healthfulness and the impact on the health of those who consume it [44].All the products evaluated in the study were reported as daily consumed by participants, suggesting that their perceptions were greatly influenced by eating habits and/or previous nutrition knowledge, suggesting that the TLS inclusion was not salient enough to modify participants' perception. Research affirm that nutritional labeling is influenced by several factors including package design, price, brand, as well as personal characteristics as education and socio-economic levels, concerns about food and health, presence of diseases in the person him/herself or in the family, and dietary restrictions [45,46]. Although most of participants in the present study demonstrated higher interest in healthy eating, this concern did not cause significant differences regarding the product's healthfulness perception. Siegrist, Leins-Hess, & Keller [46] have also reported that most consumers have prior knowledge about a food, and even if such knowledge is limited, and they

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are able to observe labeling, the expectation about the nutritional quality of foods can affect the type of information available through the TLS signs.

The results achieved in the present study corroborate those already reported by previous research, which suggest that TLS is not the most appropriate FOP scheme to improve consumers' ability to identify unhealthy foods and facilitate healthy food choices [13,18,21,22,47]. Considering the current position of the Brazilian legislation, in which several FOP schemes were investigated in order to select the one that best suits Brazilians' needs, and the results are under public consultation [12], the proposal supported by the food industry does not seem to be helpful for improving people's ability to make better food choices. Possibly, the TLS scheme would minimize any impact caused by the implementation of the referred nutrition labeling regulation on sales and food consumption. Therefore, no additional action such as food reformulation would be required on the industrialized products to meet consumer's demand for more nutritious food.

4.1. Limitations of the study

The present study had some limitations. Firstly, although the sample of consumers was diverse in terms of age and socio-economic status, participants were recruited using a small convenience sample from one Brazilian city (Rio de Janeiro). This limits the generalizability of the findings. However, our objective was to conduct a simple study for investigating the impact of FOP proposed by the food industry on the perception of product healthiness by Brazilian consumers.Secondly, the nutritional composition did not vary among samples, i.e. nutritional composition was not a factor in the design, which might have limited the results, once consumers were not exposed to healthy and unhealthy options of the same product category. Further research should focus on the influence of FOP labels on Brazilian consumers including low, medium and high nutritional quality products under the same conditions.

Considering that the ultimate goal of FOP nutrition labelling schemes is encouraging more healthful food choices [9], further research should focus on comparing the influence of TLS and other FOP nutrition labelling schemes on food choices situations.

5. Conclusion

The results found in this study corroborate the findings of previous research, which reported that the presence of TLS had a low impact in the determination of product's healthfulness by consumers, even with consumers with high interest in healthy eating. The TLS information itself was not able to reduce the healthfulness perception of unhealthy products, suggesting that the FOP model proposed by the food industry is not the most appropriate for the Brazilian population. The findings of this study also highlights the importance of an inclusion of a salient FOP scheme, favoring its use by consumersIn this sense, it is necessary the development of further studies for investigating TLS and other FOP nutritional schemes with more salient and simple information such as nutritional warnings, using a larger number of products and also with products within the same category that differ in nutritional profile. Upon further investigation, the government will have enough data to select the most appropriate FOP for the Brazilian population.

Declaration of Competing Interest

None.

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